Underwater Behavior of Blue Whales Using a Suction-cup Attached CRITTERCAM

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LONG-TERM GOALS

The overall long-term goal of the research is to examine the underwater behavior including the vocal behavior of specific blue whales. While increasing attention has been paid to the remote monitoring of blue whale behavior and vocalizations, relatively little is known about the underwater behavior for individuals animals. We seek to monitor a

OBJECTIVES

The project has the following objectives:

1. Increase sample size of integrated visual, acoustic, dive and feeding behavior of blue whales
2. Collect associated data on sighting history, sex, and size using photo-ID, biopsy sampling, and photogrametry
3. Examine differences in behavior among three different habitats and seasons
4. Bring together inter-disciplinary team of researchers to collaborate in the integration of the data components

APPROACH

Underwater video, sound, depth and temperature were recorded using a modified instrument package termed CRITTERCAM (Marshall 1998). The instrument package was developed by National Geographic and has been used on a number of marine species. The modified, Hi-8 recording camera with datalogger was housed in a 31 cm long x 10 cm diameter cylinder outfitted with a ring of high output red LEDs and hydrophone (Figure 1). The CRITTERCAM was attached to the whale with a low profile silicon suction cup (22 cm diameter) with the aid of a remote vacuum pump. Field monitoring in addition to attachment of the CRITTERCAM included photographic identification of individual animals (to be linked with sighting histories from archived data), collection of skin from biopsy or sloughed skin (to allow gender determination), and photogrammetry (to estimate size). The instrument package and field data would provide the following:

- Visual data showing the animals' body positions, swimming rate and underwater action from the Hi-8 video recorder
- Acoustic data from the onboard hydrophone that records to the Hi-8 track
- Dive data from the pressure sensor
- Temperature data
- Photo-ID of the animal obtained during tagging to allow determination of sighting history and other parameters for animal
- Gender from sloughed skin and possibly biopsy
- General size of the animal from subjective observation and fluke size based on new photogrammetry technique using laser range-finder

Figure 1. The CRITTERCAM instrument package on the back of a blue whale in the Sea of Cortez in March 2001.

WORK COMPLETED

Deployments were successfully conducted in three region in the last year. These included Monterey Bay (northern California), off San Nicholas and San Miguel Islands in southern California, and in the Sea of Cortez, Mexico. To date, 17 deployments have been conducted on blue whales, with 8 of these successfully recovered instruments that stayed on the whale from 15 minutes to over 6 hours (including a single deployment completed prior to ONR funding). A summary of field effort by region is included below:

Monterey Bay: Crittercam deployments and recoveries in 2000 were made in Monterey Bay from 12 to 19 September 2000. Six approaches were made to blue whales to attach Crittercams; in three of these approaches we made physical contact with the whale and achieved one successful deployment. Through this effort we improved our strategy for approaching whales. The successful deployment was made on the lead whale of a pair of whales on 14 September at 0947 at 36º48.02N and 121º57.40W (Figure 2). The crittercam stayed on the whale throughout that day's observations even though we expected the corroding magnesium to result in breaking the vacuum holding the suction cup on to occur in about three hours. We were able to stay with the two whales through 1949 after which deteriorating weather and light resulted in our losing the whales. The whales did not appear to change their milling behavior immediately after tag attachment. We did lose track of the whales for over one hour in the morning. Recovering the Crittercam proved challenging but was eventually achieved 3 days later on 17 September. By this time the combination of movement on the whale and drift after release had taken the tag to 36º31.57N and 122º17.80W or 23.2 nmi (43 km) from the location of attachment. Some data was lost due to the long time between tagging and recovery as a result of a small amount of moisture that condensed in the Crittercam casing. Both the lead animal that was tagged and the trailing animal in the pair were previously identified whales with long sighting histories. The animal on which the tag was deployed was ID# 111 and had been first identified in 1987 in the Gulf of the Farallones. It has been seen since then in 1990 in the Gulf of the Farallones and in 1992 off both Fort Bragg and Point Arena. The trailing animal in this pair was also a known older

animal (ID# 283) first identified in 1988 in the Gulf of the Farallones and seen in 1989 in Mexico and in 1992 in both Santa Barbara Channel and the Gulf of the Farallones.

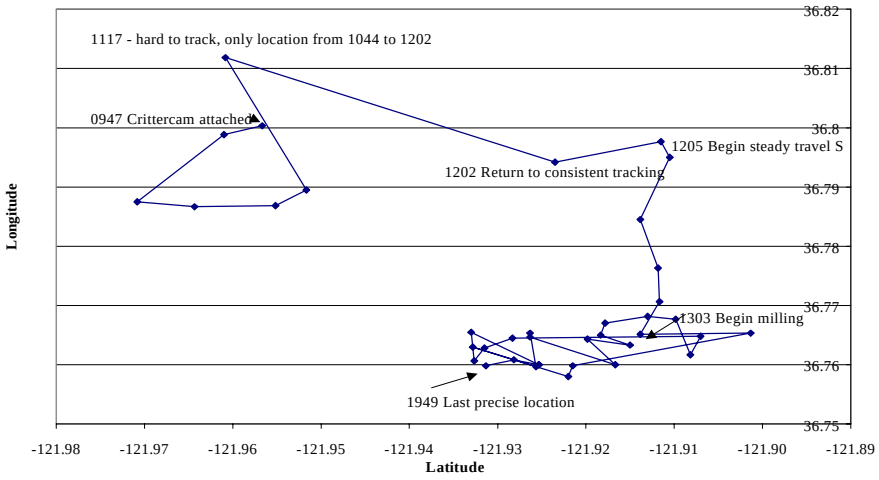

Figure 2. Movements of blue whale after attachment of Crittercam on 14 September 2000 in Monterey Bay.

Sea of Cortez: Field effort was conducted in the Sea of Cortez in collaboration with Diane Gendron of CICIMAR primarily from 26 February to 6 March 2001 with 16 deployments attempted between 28 February and 3 March. One extended deployment and recovery was achieved on a single feeding blue whales on 1 March (Figure 3). We achieved another extended deployment on 3 March but despite an extensive search extending after our field effort it was never recovered. Date from the primary deployment covered more than 6 hours extending from daylight into night and showing the dramatic shift in depths of dives (Figure 3). Comparison of the dive profile of this animal with the presence of a krill layer detected from a boat following behind the whale showed it was diving to below the krill layer and then coming into the lower portion of the layer. That observation and the collection of feces confirmed they were feeding in this area. Identification photographs were obtained of most of the animals in this area and skin samples collected from many of them.

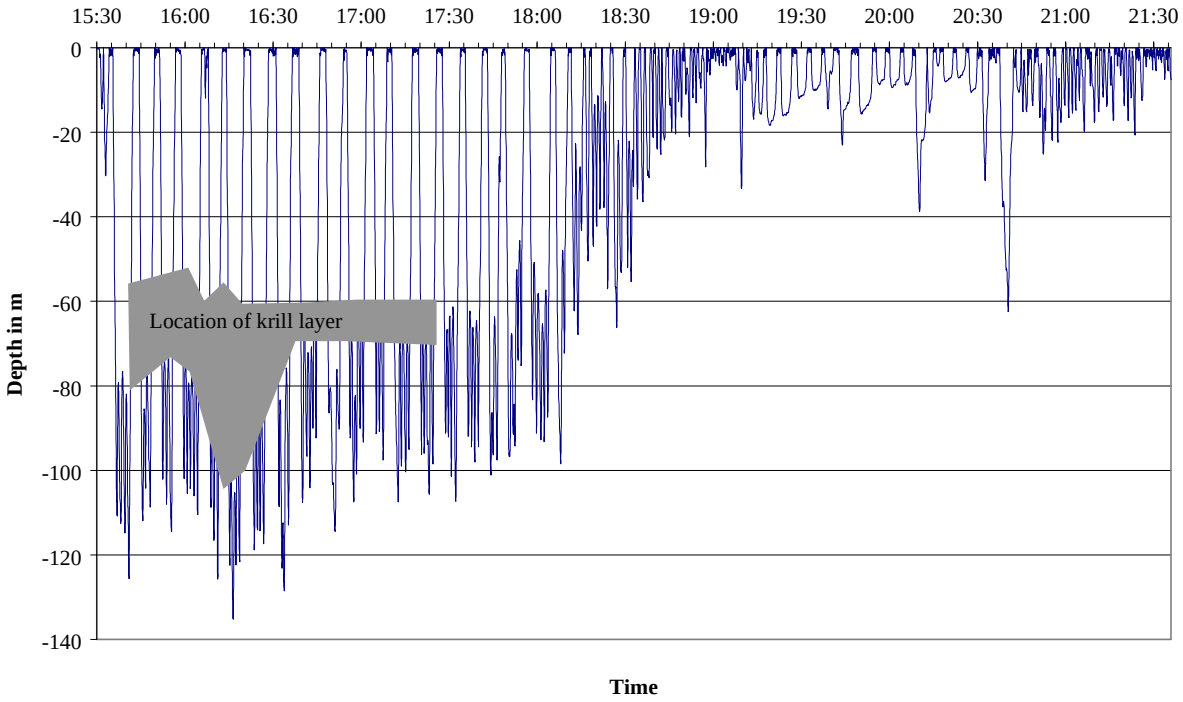

Figure 3. Dive record from Crittercam deployment on 1 March 2001 in the Sea of Cortez.

Southern California: Our third deployment effort under this grant was conducted in the southern California Bight from 14 to 26 July 2001. We had planned to work with the concentration of blue whales that typically feeds in the Santa Barbara Channel during this period. Unfortunately, there were very few blue whales present this year. We were able to identify to other areas with large blue whale concentrations just north of San Nicholas Island and southwest of San Miguel Island. Although both these areas were 50 or more nmi away from the closest harbor we were still able to effectively work in these areas with our two RHIBs. The concentration of blue whales off San Miguel Island was one of the largest we have ever documented with over 200 animals in an area less than 10 by 2 nmi. We had excellent success deploying Crittercams achieving 12 deployments, 5 of these for periods of greater than 15 minutes where the camera was recovered. We lost one camera, we suspect due to failure of the VHF transmitter, although this tag may still be recovered if it washes up on shore.

RESULTS

Results and things we have learned from these deployments include:

1. Developed the most effectively approach methods of blue whales to deploy instruments; our success rate in attaching instruments has gone from less than 10% of approaches where we contact the whale to 46%.
2. Dramatically improved the performance of the Crittercams themselves including improvements in sound quality and more effective and redundant release mechanisms.
3. Successfully obtained images of underwater behavior in conjunction with acoustical recordings and dive records of multiple animals in different regions and seasons.

Data obtained in the last year is just beginning to be analyzed. The data and images from the Crittercam instruments is being compiled with sighting histories from photo-identification, gender from skin samples, tracking positions from boats, and information on bottom topography and scattring layers from our depth sounder.

IMPACT/APPLICATIONS

Potential future impact for Science and/or Systems Application

TRANSITIONS

How these results (hardware, software, knowledge) are being utilized by others.

RELATED PROJECTS

Identify closely related projects and briefly describe the nature of each relationship.

REFERENCES

Marshall, Greg J. 1998. CRITTERCAM: an animal-borne imaging and data logging system. Mar. Tech. Soc. J. 32(1):11-17.

Williams, T.M., R.W. Davis, L.A. Fuiman, J. Francis, B.J. Le Boeuf, M. Horning, J. Calambokidis, and D.A. Croll. 2000. Energy conservation in diving marine mammals. Science 288:133-136

REFEREED PUBLICATIONS

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OTHER PUBLICATIONS

List all technical reports, conference proceedings, etc., that were published in unrefereed sources.